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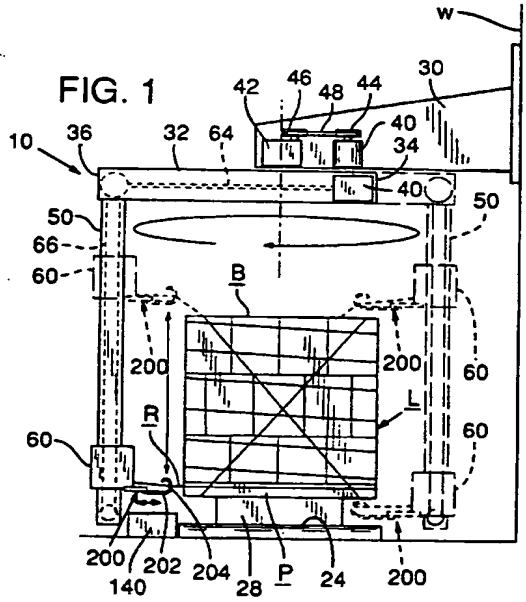
(54) Apparatus and method for wrapping a palettized load.

(57) An apparatus for wrapping a pallet load (L) with a wrapping film applied selectively as a film rope (R) or as a film sheet (F) includes means (28) to support the load (L) in an elevated position. A rotary arm (32) supported above the load (L) is arranged to be rotatably driven. An upright member (50) depending from the rotary arm (32) is spaced outwardly from the load (L). A carriage (60) is arranged to be upwardly and downwardly driven along the upright member (50). A dispenser on the carriage dispenses the wrapper as a rope (R) or as a sheet (F). A guide (200), which comprises a lever (206, 210) and a hook (204) on the lever, is moveable among extended, partly retracted, and fully retracted positions. In the extended position, the guide (200) guides the rope (R) across the respective corners of the load (L). In the partly or fully retracted position, the guide does not interfere with driving the carriage (60) along the upright member (50).

FIG. 1



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This invention pertains to an apparatus and related methods for wrapping a load having upper edges and lower edges, such as a pallet load, boxes stacked on a slip sheet, or a shipping crate, with a wrapping film, which is applicable as a film rope. The apparatus includes a guide, which guides the film rope across the upper and lower edges of the load.

An apparatus of a known type for wrapping such a load with a wrapping film is exemplified in Salzsauler U.S. Patents No. 4,934,123 and No. 4,938,008. In such an apparatus, the load is supported in an elevated position, in which each of its upper and lower corners is exposed. A rotary arm, which is supported by fixed structure above the pallet load, is arranged to be rotatably driven about a vertical axis extending through the load. An upright leg depending from the arm sweeps a cylindrical path around the load as the arm rotates. A carriage is arranged to be upwardly and downwardly driven along the upright leg. Mechanisms on the carriage are arranged to dispense a wrapping film as a film sheet, in which the wrapping film remains substantially at full width, as the arm and the carriage are driven in a suitable manner. As the arm and the carriage are driven, the film sheet is wrapped around the load in helical patterns, which may be upwardly or downwardly directed.

Furthermore, prior attempts have been made to adapt such an apparatus to dispensing a wrapping film selectively as a film rope, in which the wrapping film is bunched into a rope-like configuration, and as a film sheet, in which the wrapping film remains substantially at full width, and to wrap such a load with the wrapping film as a film rope before wrapping the load with the wrapping film as a film sheet. However, these attempts have not been entirely satisfactory.

Load-wrapping apparatus of related interest are disclosed in Lancaster et al. U.S. Patent No. 4,418,510, Geisinger U.S. Patent No. 4,432,185, and Geisinger U.S. Patent No. 4,619,102.

According to a first aspect of this invention an apparatus for wrapping a load which has upper and lower ends defining edges of the load, with a wrapping film, which is applied as a film rope, the apparatus comprising:-

(a) means for supporting the load in an elevated position, in which each edge defined by the upper and lower ends of the load is exposed;

(b) a supporting structure disposed in a fixed position above the load;

(c) a rotary arm supported by the supporting structure and arranged to be rotatably driven about a vertical axis, the rotary arm being disposed above the load in all rotated positions of the rotary arm;

(d) an upright member depending from the rotary arm and outwardly spaced from the load in all rotated positions of the rotary arm;

(e) a carriage mounted on the upright member and arranged to be selectively driven in an upward and downward direction along the upright member;

(f) means for driving the rotary arm rotatably about an upright axis in such manner that the upright member describes a cylindrical path around the load; and

(g) means for driving the carriage selectively in an upward or downward direction along the upright member is characterised in that it also includes:

(h) means for dispensing a wrapping film from the carriage as a film rope, in which the wrapping film is bunched into a rope-like configuration;

(i) means including a rope guide moveable between an extended position and a retracted position for guiding the film rope selectively so as to guide the film rope above and across the upper end of the load and below and across the lower end of the load as the rotary arm is driven rotatably with the carriage held at stationary positions relative to the upright member and with the guide in the extended position, the guide moving to a retracted position to avoid interference between it and the load as the carriage is driven in either direction along the upright member; and,

(j) means for moving the rope guide selectively between its extended and retracted positions.

According to a second aspect of this invention a method of wrapping a load with a wrapping film, the load having six mutually orthogonal faces defining four upper corners and four lower corners, comprises the steps of:

(a) forming a film rope from the wrapping film;

(b) holding a free end of the film rope; and,

(c) wrapping the load with the film rope in a pattern, in which the film rope passes above and across each of the upper corners and below and across each of the lower corners.

This method and apparatus provides an advantage in that it is capable of wrapping a load diagonally with a film rope, which not only ties the load together but also compresses it vertically, as well as horizontally. As compared to a film sheet of a given material, a film rope of the same material tends to be considerably stronger per unit wrapping area.

Preferably, the rope guide comprises a lever and a hook, which is integral with the lever. The lever is mounted pivotally on the carriage between an extended position of the rope guide and a retracted position of the rope guide. The film rope passes through the hook as the film rope is dispensed by the dispensing device.

In a preferred construction, the hook is capable of performing important functions. In the preferred construction, upon pivotal movement of the lever from the fully retracted position into a partly retracted position after the wrapping film has been established as a film rope, the hook engages the film rope automatically.

Also, upon pivotal movement of the lever in either direction between the partly retracted and fully extended positions, the hook retains the film rope. Moreover, upon pivotal movement of the lever from the partly retracted position into the fully retracted position, the hook disengages the film rope automatically.

The method and apparatus may be advantageously used for wrapping a pallet load, which is shaped generally as a rectangular solid having upper edges defining upper corners and lower edges defining lower corners, with a wrapping film, which is applied selectively as a film rope or as a film sheet. The dispensing device may be thus arranged for dispensing a wrapping film from the carriage selectively as a film rope or as a film sheet.

Moreover, if the rope guide comprises a lever and a hook, as described above, the improved apparatus may comprise a device for preventing the carriage-driving device from driving the carriage in either direction along the upright member whenever the lever is in the position corresponding to the extended position of the rope guide.

In the fully retracted position, the lever and the hook are disposed so as to avoid interference with the wrapping film when the wrapping film is being dispensed as a film sheet.

A particular embodiment of a method and apparatus in accordance with this invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a largely diagrammatic, elevational view of an apparatus for wrapping a pallet load with a wrapping film, which may be selectively applied as a film rope or as a film sheet, and which is shown as a film rope;

Figures 2A. 2B, and 2C are largely diagrammatic, plan views of the same apparatus at various stages in its operation;

Figure 3 is a diagrammatic development showing one possible pattern for wrapping the pallet load with the film rope;

Figure 4 is a largely diagrammatic, elevational view of a carriage of the same apparatus, as taken from a side showing mechanisms for bunching the wrapping film into the film rope;

Figure 5 is a largely diagrammatic, elevational view of the same carriage, as taken from a side showing a rope guide and related devices;

Figure 6 is a largely diagrammatic, plan view of the same carriage with the rope guide being shown in three different positions in full and broken lines, and with portions of the pallet load and an underlying support being shown in broken lines;

Figure 6A is an enlarged detail taken substantially from Figure 6 with some features sectioned differently;

Figure 6B is a perspective view of the rope guide removed from the apparatus;

Figure 7 is a schematic diagram showing certain pneumatic valves of the apparatus;

Figure 8 is a diagrammatic representation of the film rope, as wrapped around the pallet load in one possible pattern before the pallet load is wrapped with a film sheet; and,

Figure 9 is a diagrammatic representation of a film sheet, as wrapped around the pallet load in one possible pattern after the pallet load has been wrapped with the film rope.

As shown in Figure 1 and elsewhere in the drawings, an apparatus 10 for wrapping a load with a wrapping film constitutes a preferred embodiment of this invention. The apparatus 10 is an improved version of the apparatus disclosed in Salzsauler U.S. Patents No. 4,934,123 and No. 4,938,008, the disclosures of which are incorporated herein by reference. The apparatus 10 comprises a film-cutting and heat-sealing mechanism to be later described, which is similar to the film-cutting and heat-sealing mechanism disclosed in European Patent Application No. 91311831.1 published as EP-A- , the disclosure of which is incorporated herein by reference. The apparatus 10 differs from the apparatus disclosed in the Salzsauler patents noted above, and from the apparatus disclosed in the European patent application noted above, by comprising a rope guide to be later described. The rope guide facilitates applying the wrapping film as a film rope, in which the wrapping film is bunched into a rope-like configuration, by guiding the film rope across upper and lower surfaces of the load.

As shown in the drawings, the load Is a pallet load L, which comprises plural boxes B stacked on a pallet P. It is possible to substitute a slip sheet (not shown) for the pallet P. The apparatus 10 may be alternatively used with a load (not shown) having different characteristics, such as stacked boxes without a pallet or a slip sheet beneath such boxes, or a shipping crate, which does not require a pallet or a slip sheet. As shown in the drawings, the load L is shaped generally as a rectangular solid having six mutually orthogonal faces, which define four upper corners and four lower corners. In Figures 2A, 2B, 2C, and 3, the generally vertical edges of the load L are numbered 1, 2, 3, and 4 respectively.

As shown in Figures 1 and 2, the apparatus 10 comprises a roller conveyor 20 having an inlet portion 22, a middle portion 24, and an outlet portion 26. The middle portion 24 comprises a platform 28, which is adapted to support the load L, and which is arranged to be selectively elevated or lowered. The platform 28 has an upper surface smaller than the lower surface of the load L. In Figure 1, the platform 28 is shown in an elevated position, in which the platform 28 supports the load L in an elevated position so that all upper and lower corners of the load L are exposed. The

roller conveyor 20 comprises known means (not shown) for selectively elevating and lowering the platform 28 with the load L supported on the platform 28.

The apparatus 10 comprises a supporting structure 30, which is disposed in a fixed position above the load L. As shown in Figure 1, the supporting structure 30 is mounted to a wall W, such as a building wall or a free-standing support. A rotary arm 32 having a proximal end 34 and a distal end 36 is supported by and beneath the supporting structure 30, near the proximal end 34, and is arranged to be rotatably driven about a vertical axis. The rotary arm 32 is disposed above the load L in any rotated position of the arm 32.

A motor 40, which is mounted to the supporting structure 30, and a gear reducer 42, which also is mounted thereto and which is arranged to drive the arm 32 directly, are arranged to drive the arm 32, via a pulley 44 driven by the motor 40, a pulley 46 arranged to drive the arm 32, and an endless belt 48 connecting the pulleys 44, 46, in a manner disclosed in Salzsauler U.S. Patent No. 4,938,008, supra. A hollow, upright member 50, which depends from the distal end 36 of the rotary arm 32, sweeps a cylindrical path around the load L as the rotary arm 32 rotates. A carriage 60, which is mounted to the upright member 50, is arranged to be selectively driven along the upright member 50, either in an upward direction or in a downward direction. A motor 62, which is carried by the rotary arm 32, is arranged to drive the carriage 60 upwardly or downwardly along the upright member 50, via a drive shaft 64 and an endless chain 66, in a manner disclosed in Salzsauler U.S. Patent No. 4,938,008, supra.

The carriage 60 is similar in many respects to the carriage disclosed in Salzsauler U.S. Patent No. 4,934,123, supra. Thus, the carriage 60 comprises opposite mounts 70, 72, which are arranged to hold a roll of wrapping film F, such as so-called "stretch" film. Also, the carriage 60 is arranged to feed the wrapping film F from the roll successively around a direction-changing roller 74, around a pair of pre-stretching rollers 76, 78, which operate in a known manner, around a roller 80 on a dancer bar, which operates in a known manner, and around a direction-changing roller 84, so as to dispense the wrapping film F either as a film rope R or as a film sheet S.

As shown in Figure 4, the carriage 60 comprises a pair of film-roping sheaves 90, 92. The sheaves 90, 92, are arranged so that, as the wrapping film F is dispensed from the roll, the lower edge of the wrapping film F engages the sheave 90 and the upper edge of the wrapping film F engages the sheave 92. The sheaves 90, 92, are moveable selectively to allow the wrapping film F to be normally dispensed from the roll as a film sheet S having a substantially full width or to bunch the wrapping film F into a film rope R having a substantially rope-like configuration.

The sheave 90 is mounted rotatably to a bracket 94, which is moveable conjointly with the piston of a double-acting, pneumatic, piston-cylinder mechanism 96, along a vertical member 98. Thus, the sheave 90 is moveable between a lower position, in which it is shown in broken lines in Figure 4, and an upper position, in which it is shown in full lines therein, over a range indicated by a relatively short, double-headed arrow in Figure 4. The sheave 92 is mounted rotatably to a bracket 100, which is mounted moveably on a vertical member 102. Thus, the sheave 92 is moveable between a lower position, in which it is shown in full lines in Figure 4, and an upper position, in which it is shown in broken lines therein, over a range indicated by a relatively long, double-headed arrow in Figure 4.

The bracket 100 mounting the sheave 90 is connected to an endless chain 104, via a link 106, for conjoint movement with the endless chain 104 between the upper and lower positions of the sheave 90. The endless chain 104 is deployed around a relatively small, upper sprocket wheel 108 and around a relatively small, lower sprocket wheel 110. The bracket 94 mounting the sheave 92 is connected to an endless chain 112, via a link 114, for conjoint movement with the endless chain 112. The endless chain 112 is deployed around a relatively large, upper sprocket wheel 116 and around a relatively small, lower sprocket wheel 118. The upper sprocket wheels 108, 116, are mounted to the carriage 60 for conjoint rotation about a common axis. The lower sprocket wheels 110, 118, are mounted to the carriage 60 for rotation of each about its own axis.

In a sheet-wrapping mode, the piston-cylinder mechanism 96 is actuated in a forward direction so as to move the sheave 90 to its lower position and so as to move the sheave 92 to its upper position, whereby the wrapping film F is dispensed as a film sheet S. In a rope-wrapping mode, the piston-cylinder mechanism 96 is actuated in a reverse direction so as to move the sheave 90 to its upper position and so as to move the sheave 92 to its lower position, whereby the wrapping film F is dispensed as a film rope R.

A film-cutting and heat-sealing mechanism 140 is provided, which is similar to the film-cutting and heat-sealing mechanism disclosed in the European Patent Application No. 91311831.1, supra. As shown in Figures 2A, 2B, and 2C, the mechanism 140 comprises a clamping and cutting device 142, which is used to clamp a free end of the wrapping film F at the beginning of a wrapping cycle and at the conclusion of the wrapping cycle, and which is used to cut off the final layer of the wrapping film F at the conclusion of the wrapping cycle. Also, the mechanism 140 comprises a pair of film guides 144, 146, which are used to grasp the next-to-final and final layers of the wrapping film F, as a film rope R, before such layers are heat-sealed to each other and before the final layer is cut off. Moreover, the mechanism 140 comprises an anvil 148,

against which such layers are disposed when heat-sealed to each other, a heating bar 150 for heating such layers so as to weld such layers, and a pressing bar 152 for pressing the heated layers against each other and against the anvil 148. Further details of the mechanism 140 and its operation are found in the Diehl patent application noted above. Its usage in the apparatus 10 is explained hereinafter.

According to this invention, the apparatus comprises a rope guide 200, which is moveable among three positions, as shown in Figure 6. In a first, extended position, in which the rope guide 200 is shown in broken lines in Figure 6, the rope guide 200 guides the wrapping film F, as the film rope R, across the upper and lower corners of the load L as the rotary arm 32 is driven rotatably with the carriage 60 held at suitable positions along the upright member 50. In a second, partly retracted position, in which the rope guide 200 also is shown in broken lines in Figure 6, the rope guide 200 is disposed so as to avoid interference between the rope guide 200 and the load L as the carriage 60 is driven upwardly or downwardly along the upright member 50. In a third, fully retracted position, the rope guide 200 is disposed so as to avoid interference with the film sheet S as the film sheet S is dispensed by the aforenoted rollers on the carriage 60.

As shown in Figures 5, 6, 6A, and 6B and elsewhere in the drawings, the rope guide 200 comprises a lever 202 and a hook 204, which is integral with the lever 202. The lever 202 comprises a first bar 206, a tab 208 welded to a proximal end of the first bar 206, and a second bar 210 welded to a distal end of the first bar 206 at a proximal end of the second bar 210. The hook 204 is bolted to a distal end of the second bar 210 and is curved upwardly and backwardly, as shown, so as to conform generally to a circular arc of about 220° to about 230°. A brace 212 is welded to the first bar 206, at a lower end of the brace 212, so as to extend upwardly and backwardly. A tab 214, which is spaced above the tab 208, is welded to an upper end of the brace 212. A tab 216 is welded to the brace 212 at a midportion of the brace 212.

A generally C-shaped bracket 220 having an upper arm 222 and a lower arm 224 parallel to the upper arm 222 is bolted to the carriage 60. The rope guide 200 is mounted pivotally to the carriage 60 for pivotal movement about a generally vertical axis among the first, second, and third positions noted above, via a pivot pin 230 extending through suitable apertures in the tab 214 and in the upper arm 222, and via a pivot pin 232 extending through suitable apertures in the tab 208 and in the lower arm 224.

The curvature and placement of the hook 204 enable the hook 204 to perform important functions. Upon pivotal movement of the lever 202 from the fully retracted position into the partly retracted position after the wrapping film W has been established as a film rope R, the hook 204 engages the film rope automatically. Upon pivotal movement of the lever 202 in either direction between the partly retracted and fully extended positions, the hook 204 retains the film rope R. Upon pivotal movement of the lever 202 from the partly retracted position into the fully retracted position, the hook 204 disengages the film rope R automatically.

A double-acting, pneumatic, piston-cylinder mechanism 250 is mounted pivotally to a plate 252, which is welded to the bracket 220, via a pivot pin 254. A piston of the mechanism 250 is connected to the tab 216, via a piston rod 256 of the mechanism 250, a link 258 fixed to the piston rod 256, and a pivot pin 260, which passes through suitable apertures in the link 258 and in the tab 216. Thus, when the piston 256 is advanced, the rope guide 200 is pivoted toward its extended position. Also, when the piston 256 is retracted, the rope guide 200 is pivoted oppositely.

As shown in Figure 7, the mechanism 250 is arranged to be selectively actuated, via a double-acting, solenoid-actuated, three-position, pneumatic valve 270, which is connected to a source (not shown) of pressurized air. The valve 270 is switchable from a center (standby) position, in which all ports of the valve 270 are blocked, either to a piston-advancing position, in which the valve 270 is shown in Figure 7, or to a piston-retracting position. In the piston-advancing position, the valve 270 allows air pressure to advance the piston 256 of the mechanism 250. In the piston-retracting position, the valve 270 allows air pressure to retract the piston 256. Similar pneumatic flow restrictors 272, 274, are connected between the valve 270 and the opposite ends of the mechanism 250 so as to prevent rapid acceleration or deceleration of the piston 256. As shown in Figure 7, a solenoid-actuated, normally open, pneumatic valve 276 is connected between the flow restrictor 272 and the valve 270, and a solenoid-actuated, normally open, pneumatic valve 278 is connected between the flow restrictor 274 and the valve 270. When closed, the valve 276 blocks air discharge from the mechanism 250 so as to prevent the piston 256 from retracting further. When closed, the valve 278 blocks air discharge from the mechanism 250 so as to prevent the piston from advancing further.

A limit switch 280 having an actuating lever 282 is mounted operatively on the carriage in a position where the actuating lever 282 is engaged when the rope guide 200 is pivoted from the first, extended position into the second, partly retracted position and where the actuating lever 282 is disengaged when the rope guide 200 is pivoted from the third, fully retracted position past the second, partly retracted position. The limit switch 280 is used to control the solenoid-actuated valves 276, 278, as discussed below. Also, the limit switch 280 is used to disable the motor 62 so as to prevent the carriage 60 from being moved upwardly or downwardly along the upright member 50 when-

ever the rope guide 200 is pivoted to the extended position, either above or below the load L.

All operations of the apparatus 10 may be computer-controlled. A typical sequence of such operations is to be next described.

Initially, the film-roping sheaves 90, 92, are moved, via the piston-cylinder mechanism 96, so as to establish the wrapping film F as a film rope R. A free end of the film rope R is held by the film-cutting and heat-sealing mechanism 140. The load L is centered on the platform 28, which is elevated so as to expose all upper and lower corners of the load L. The film rope R is deployed through the hook 204 of the rope guide 200, which is pivoted to the partly retracted position, via the valve 270, the valve 278, and the limit switch 280. Thereupon, a wrapping cycle is performed, as shown in Figures 2A, 2B, 2C, 3, 8, and 9.

As the wrapping cycle begins, the carriage 60 is moved upwardly on the upright member 50 and the rotary arm 32 is rotated simultaneously, whereby the film rope R is wrapped initially around the load edge 1 at a midpoint of the load edge 1 and along an upper part of the load face between the load edge 1 and the load edge 2.

When the film rope R passes above the load L, the rope guide 200 is pivoted to its fully extended position, in which the rope guide 200 remains as the film rope R is wrapped above and across the upper corner including the load edge 2, upon further rotation of the rotary arm 32 as the carriage 60 is held in a stationary position relative to the upright member 50. Thereupon, the rope guide 200 is pivoted to its partly retracted position, whereupon the carriage 60 is moved downwardly along the upright member 50 as the rotary arm 32 is rotated simultaneously, whereby the film rope R is wrapped along the load face between the load edge 2 and the load edge 3.

When the film rope R passes below the load L, the rope guide 200 is pivoted to its fully extended position, in which the rope guide 200 remains as the film rope R is wrapped below and across the lower corner including the load edge 3, upon further rotation of the rotary arm 32 as the carriage 60 is held in a stationary position relative to the upright member 50. Thereupon, the rope guide 200 is pivoted to its partly retracted position, whereupon the carriage 60 is moved upwardly along the upright member 50 as the rotary arm 32 is rotated simultaneously, whereby the film rope R is wrapped along the load face between the load edge 3 and the load edge 4.

When the film rope R passes above the load L, the rope guide 200 is pivoted to its fully extended position, in which the rope guide 200 remains as the film rope R is wrapped above and across the upper corner including the load edge 4, upon further rotation of the rotary arm 32 as the carriage 60 is held in a stationary position relative to the upright member 50. Thereupon, the rope guide 200 is pivoted to its partly retracted position, whereupon the carriage 60 is moved downwardly along the upright member 50 as the rotary arm 32 is rotated simultaneously, whereby the film rope R is wrapped along the load face between the load edge 4 and the load edge 1.

When the film rope R passes below the load L, the rope guide 200 is pivoted to its fully extended position, in which the rope guide 200 remains as the film rope R is wrapped below and across the lower corner including the load edge 1, upon further rotation of the rotary arm 32 as the carriage 60 is held in a stationary position relative to the upright member 50. Thereupon, the rope guide 200 is pivoted to its partly retracted position, whereupon the carriage 60 is moved upwardly along the upright member 50 as the rotary arm 32 is rotated simultaneously, whereby the film rope R is wrapped along a lower part of the load face between the load edge 1 and the load edge 2, around the load edge 2 at a location between the upper and lower corners including the load edge 2, and along an upper part of the load face between the load edge 2 and the load edge 3.

When the film rope R passes above the load L, the rope guide 200 is pivoted to its fully extended position, in which the rope guide 200 remains as the film rope R is wrapped above and across the upper corner including the load edge 3, upon further rotation of the rotary arm 32 as the carriage 60 is held in a stationary position relative to the upright member 50. Thereupon, the rope guide 200 is pivoted to its partly retracted position, whereupon the carriage 60 is moved downwardly along the upright member 50 as the rotary arm 32 is rotated simultaneously, whereby the film rope R is wrapped along the load face between the load edge 3 and the load edge 4.

When the film rope R passes below the load L, the rope guide 200 is pivoted to its fully extended position, in which the rope guide 200 remains as the film rope R is wrapped below and across the lower corner including the load edge 4, upon further rotation of the rotary arm 32 as the carriage 60 is held in a stationary position relative to the upright member 50. Thereupon, the rope guide 200 is pivoted to its partly retracted position, whereupon the carriage 60 is moved upwardly along the upright member 50 as the rotary arm 32 is rotated simultaneously, whereby the film rope R is wrapped along the load face between the load edge 4 and the load edge 1.

When the film rope R passes above the load L the rope guide 200 is pivoted to its fully extended position, in which the rope guide 200 remains as the film rope R is wrapped above and across the upper corner including the load edge 1, upon further rotation of the rotary arm 32 as the carriage 60 is held in a stationary position relative to the upright member 50. Thereupon, the rope guide 200 is pivoted to its partly retracted position, whereupon the carriage 60 is moved downwardly along the upright member 50 as the ro-

tary arm 32 is rotated simultaneously, whereby the film rope R is wrapped along the load face between the load edge 1 and the load edge 2.

When the film rope R passes below the load L, the rope guide 200 is pivoted to its fully extended position, in which the rope guide 200 remains as the film rope R is wrapped below and across the lower corner including the load edge 4, upon further rotation of the rotary arm 32 as the carriage 60 is held in a stationary position relative to the upright member 50. Thereupon, the rope guide 200 is pivoted to its partly retracted position, whereupon the carriage 60 is moved upwardly (at a relatively slow rate) along the upright member 50 as the rotary arm 32 is rotated simultaneously, whereby the film rope R is wrapped in a upwardly directed, spiral pattern around eleven successive load faces starting with the load face between the load edge 2 and the load edge 3 and ending with the load face between the load edge 4 and the load edge 1.

Subsequently, the film-roping sheaves 90, 92, are moved, via the piston-cylinder mechanism 96, so as to reestablish the wrapping film F as a film sheet S. Thereupon, after the free end of the film rope R is released by the film-cutting and heat-sealing mechanism 140, the carriage 60 is moved downwardly (at a similarly slow rate) along the upright member 50 as the rotary arm 32 is rotated simultaneously, whereby the film sheet S is wrapped in a downwardly directed pattern around eleven successive load faces starting with the load face between the load edge 1 and the load edge 2 and ending with the load face between the load edge 4 and the load edge 1, and whereby the free end released by the mechanism 140 is wrapped by the film sheet S. Thereupon, the film-roping sheaves 90, 92, are moved, via the piston-cylinder mechanism 96, so as to reestablish the wrapping film F as a film rope R, whereupon the film-cutting and heat-sealing mechanism 140 is operated in the manner disclosed in the European patent application, supra, so as to heat seal and cut off the film rope R. Generally, the film rope R is wrapped around the load L in two successive layers, the outer layer being engaged by the film guides 144, 146, as shown in Figure 2B, whereupon the outer layer is heat-sealed to the inner layer and is cut off by the mechanism 140, as shown in Figure 2C.

It may be thus seen that the rope guide 200 enables the apparatus 10 to wrap the load L diagonally or sinusoidally with the wrapping film F, as a film rope R, which not only ties the load L but also compresses the load L vertically, as well as horizontally. The apparatus 10 is capable, moreover, of overwrapping the tied load L with the wrapping film F, as a film sheet S.

Claims

1. Apparatus (10) for wrapping a load (L), which has upper and lower ends defining edges of the load (L), with a wrapping film (F), which is applied as a film rope (R), the apparatus comprising:-
   (a) means (28) for supporting the load (L) in an elevated position, in which each edge defined by the upper and lower ends of the load (L) is exposed;
   (b) a supporting structure (30) disposed in a fixed position above the load (L);
   (c) a rotary arm (32) supported by the supporting structure (30) and arranged to be rotatably driven about a vertical axis, the rotary arm being disposed above the load (L) in all rotated positions of the rotary arm (32);
   (d) an upright member (50) depending from the rotary arm (32) and outwardly spaced from the load (L) in all rotated positions of the rotary arm (32);
   (e) a carriage (60) mounted on the upright member (50) and arranged to be selectively driven in an upward and downward direction along the upright member (50);
   (f) means (40, 42) for driving the rotary arm (32) rotatably about an upright axis in such manner that the upright member (50) describes a cylindrical path around the load (L); and
   (g) means (62, 64, 66) for driving the carriage (60) selectively in an upward or downward direction along the upright member (50);
   characterised in that it also includes:
   (h) means (90, 92) for dispensing a wrapping film (F) from the carriage (60) as a film rope (R), in which the wrapping film (F) is bunched into a rope-like configuration (R);
   (i) means (200) including a rope guide (204) moveable between an extended position and a retracted position for guiding the film rope (R) selectively so as to guide the film rope (R) above and across the upper end of the load (L) and below and across the lower end of the load (L) as the rotary arm (32) is driven rotatably with the carriage (60) held at stationary positions relative to the upright member (50) and with the guide (204) in the extended position, the guide (204) moving to a retracted position to avoid interference between it and the load (L) as the carriage (60) is driven in either direction along the upright member (50); and,
   (j) means (250) for moving the rope guide (204) selectively between its extended and retracted positions.

2. An apparatus according to claim 1, wherein the

rope guide (200) comprises a lever (206,210) which is mounted pivotally on the carriage (60) and which is pivotable selectively between one position corresponding to the extended position of the rope guide (204) and another position corresponding to the retracted position of the rope guide (204), and wherein the rope guide comprises a hook (204) which is integral with the lever (206, 210) and through which the film rope (R) passes as the film rope (R) is dispensed.

3. An apparatus according to claim 2, comprising means (280) for preventing the carriage-driving means (62) from driving the carriage (60) in either direction along the upright member (50) whenever the lever (206, 210) is in its extended position.

4. An apparatus according to any one of the preceding claims, wherein the means for dispensing a wrapping film from the carriage (60) selectively dispenses the film (F) as a film rope (R), in which the wrapping film is bunched into a rope-like configuration, or as a film sheet (F), in which the wrapping film remains substantially at full width.

5. An apparatus according to claim 4, wherein the rope guide is also pivotable selectively to a partly retracted position, and wherein in its fully retracted psoition, the lever (206, 210) is disposed so as to avoid interference with the wrapping film (F) when dispensed as a film sheet (F).

6. An apparatus according to claim 5, wherein the hook (204) constitutes means for engaging the film rope (R) automatically when the lever (206, 210 is pivoted from the fully retracted position into the partly retracted position, for retaining the film rope (R) during pivotal movement of the lever (206, 210) in either direction between the partly retracted position and the extended position, and for releasing the film rope (R) automatically upon pivotal movement of the lever (206, 210) from the partly retracted position into the fully retracted position.

7. A method of wrapping a load (L) with a wrapping film (F), the load (L) having six mutually orthogonal faces defining four upper corners and four lower corners (C), the method comprising the steps of:
   (a) forming a film rope (R) from the wrapping film (F);
   (b) holding a free end of the film rope (R); and,
   (c) wrapping the load with the film rope in a pattern, in which the film rope passes above and across each of the upper corners and below and across each of the lower corners.

8. A method according to claim 7, comprising a further step of:
   (d) wrapping the load (L) with the film rope in a helical pattern.

9. A method according to claim 8, comprising the further steps of:
   (e) forming a film sheet (F) from the wrapping film, after wrapping the load (L) with the film rope (R) in the helical pattern; and
   (f) wrapping the load (L) with the film sheet (F).

10. A method according to claim 9, wherein the free end is released before the load (L) is wrapped with the film sheet (F).

FIG. 1

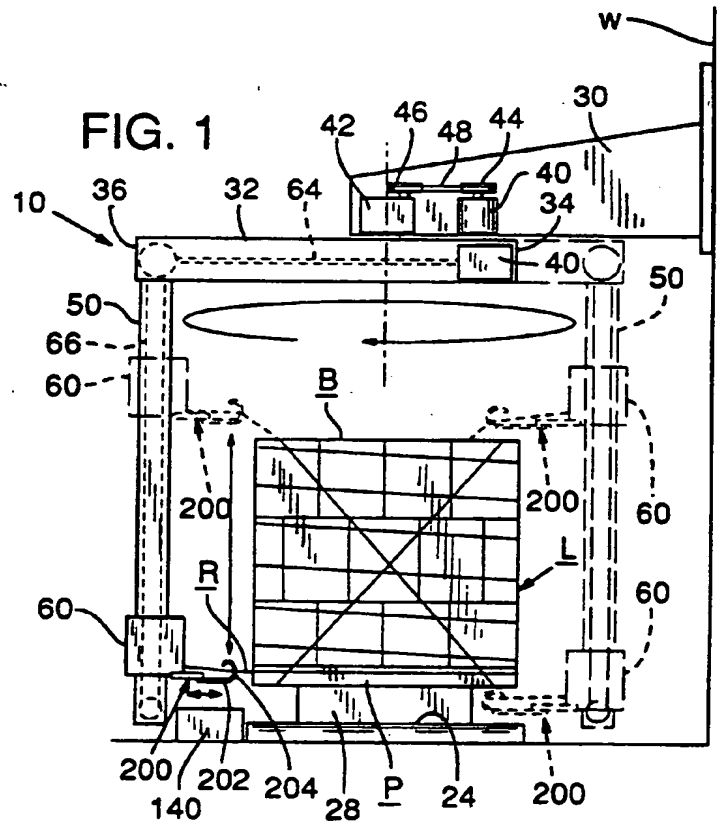

W
30
42
46
48
44
40
34
10
36
32
64
40
50
50
66
60
B
200
200
60
R
L
60
60
200
202
204
28
P
24
200
140

FIG. 3

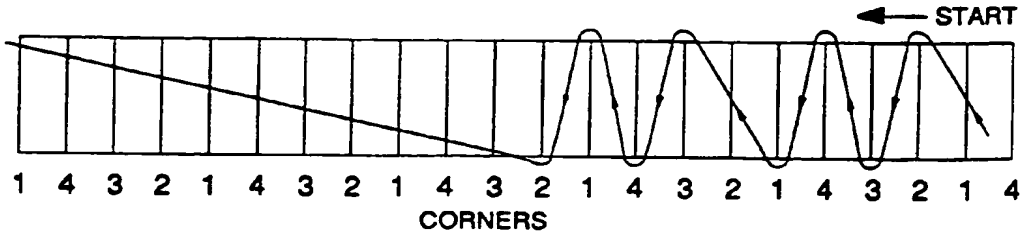

START
1 4 3 2 1 4 3 2 1 4 3 2 1 4 3 2 1 4 3 2 1 4
CORNERS

FIG. 2A

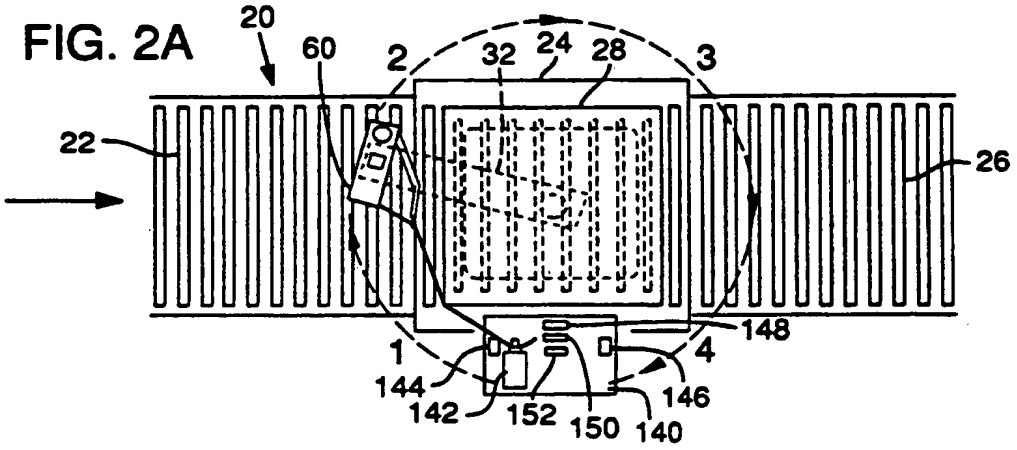


FIG. 2B

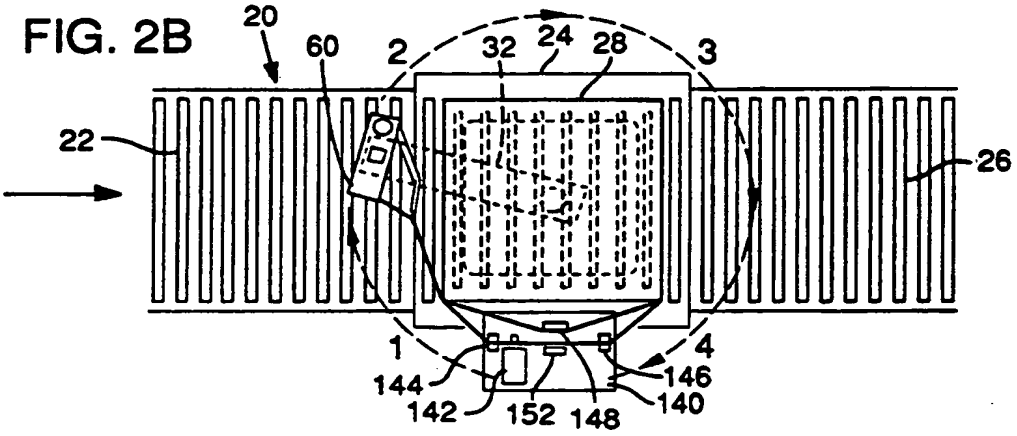


FIG. 2C

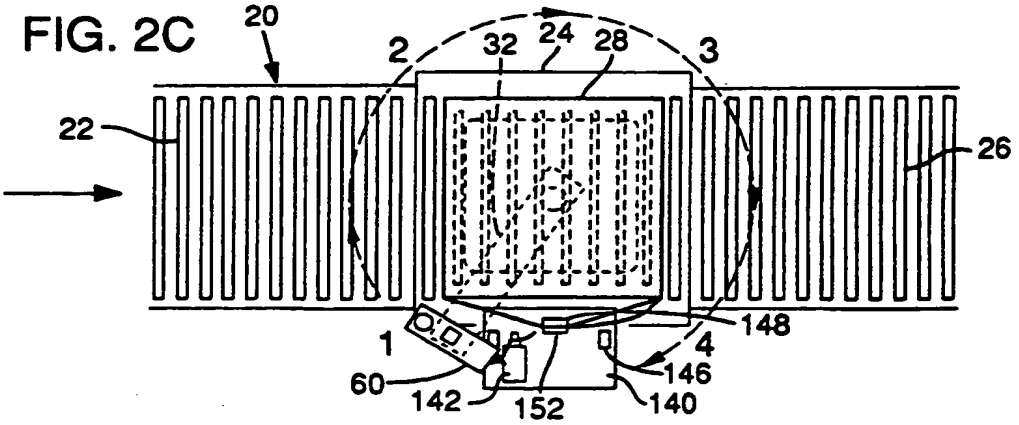


FIG. 4

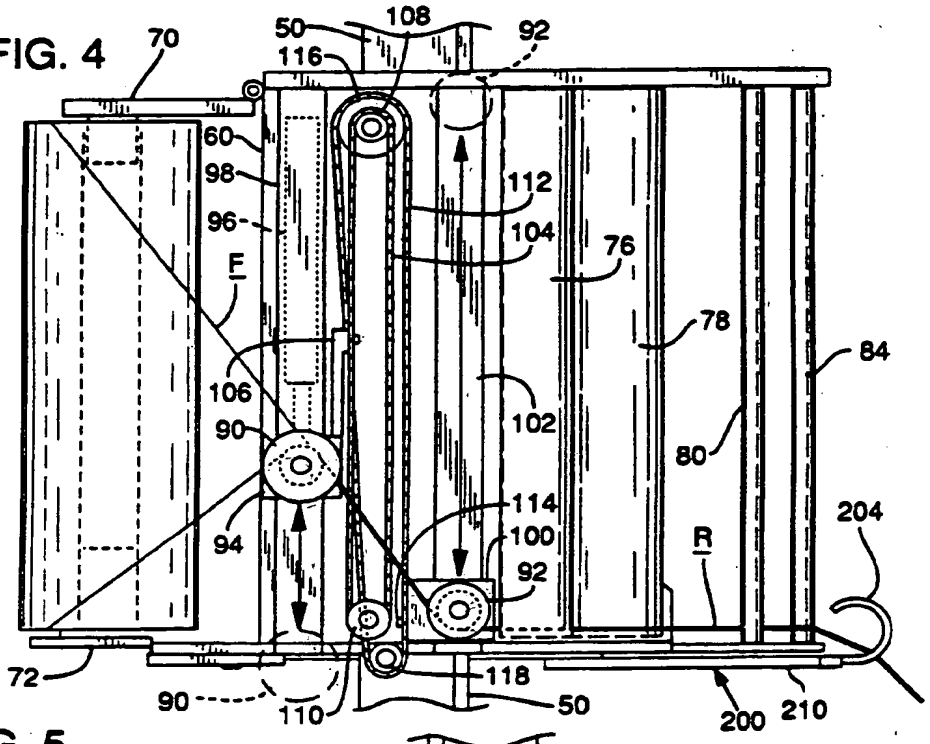
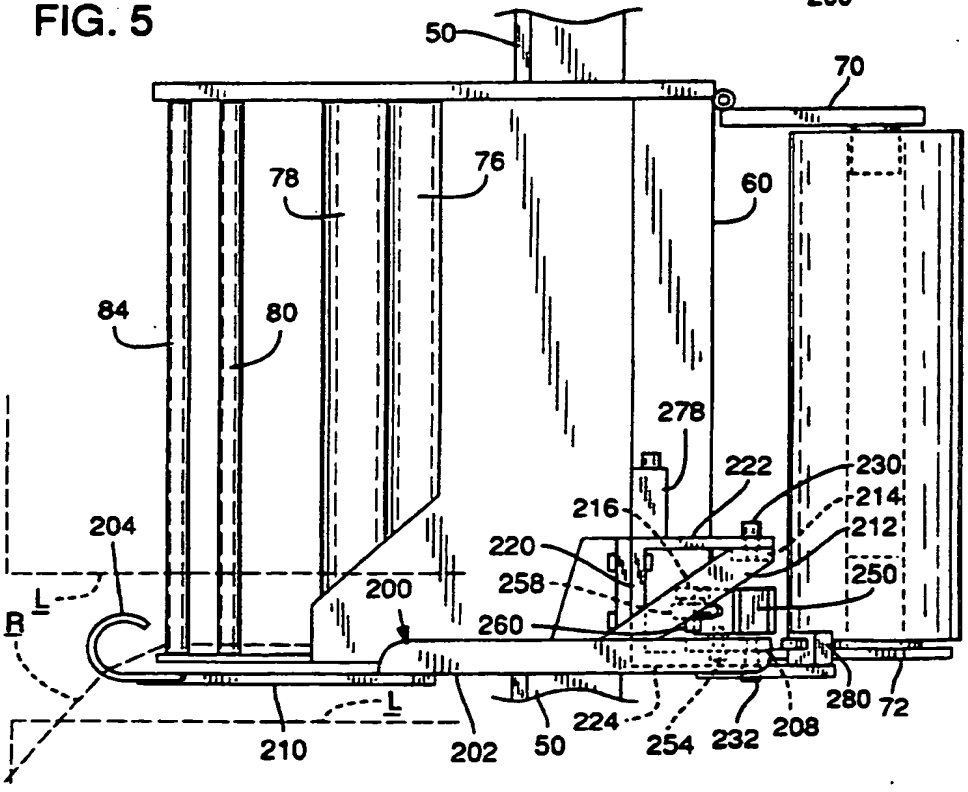

70
50
108
92
116
60
98
112
96
104
76
F
78
84
106
102
90
80
114
204
94
100
R
92
72
118
90
50
110
200
210

FIG. 5


50
70
78
76
60
84
80
278
222
230
216
214
204
212
220
250
258
200
260
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R
280
72
L
224
210
202
50
254
232
208

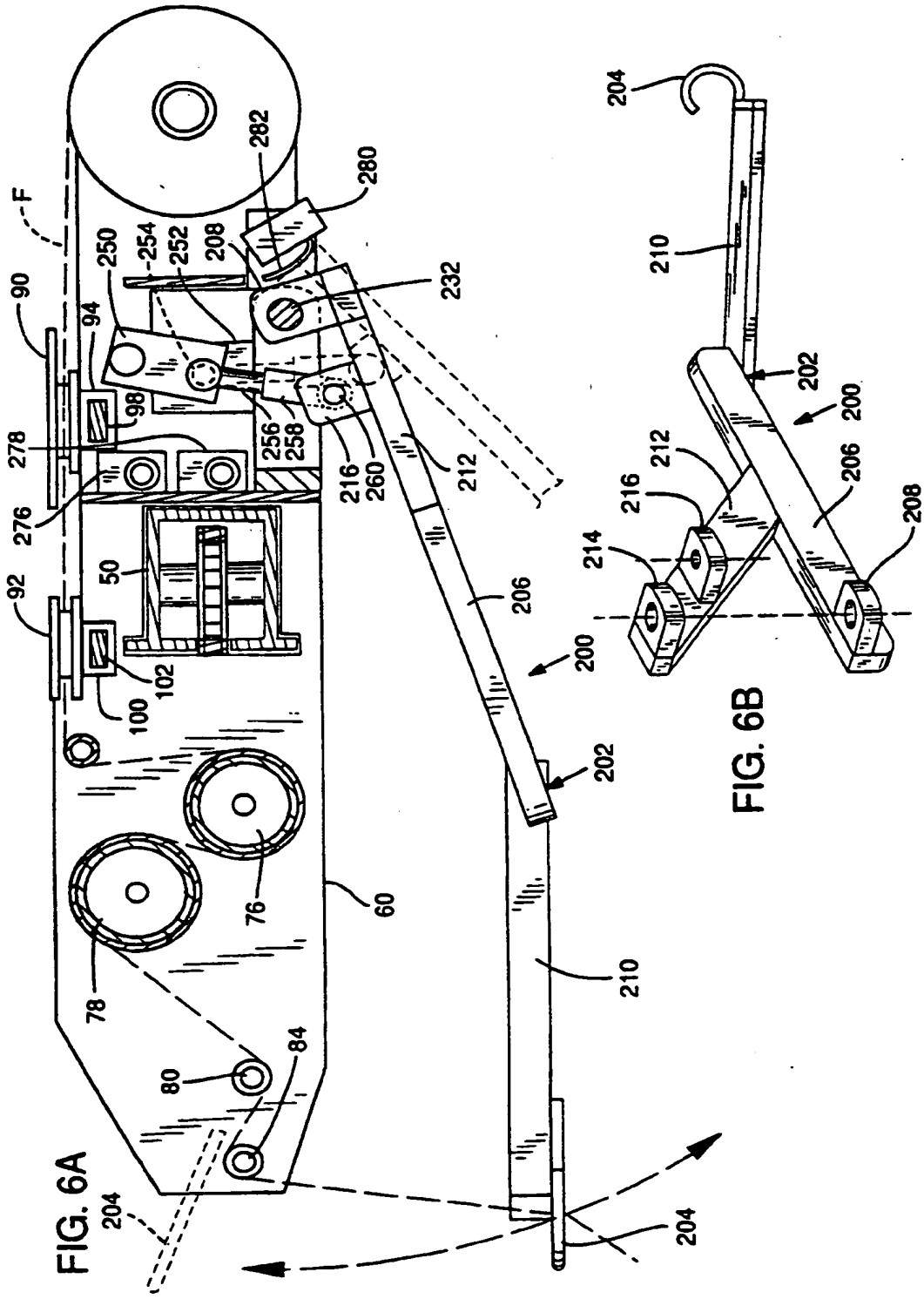
F
90
92
94
98
100
102
50
276
278
250
254
252
208
282
280
232
256
258
216
260
212
206
200
202
210
204
60
76
78
80
84

FIG. 6A

204
210
202
200
212
216
214
206
208

FIG. 6B

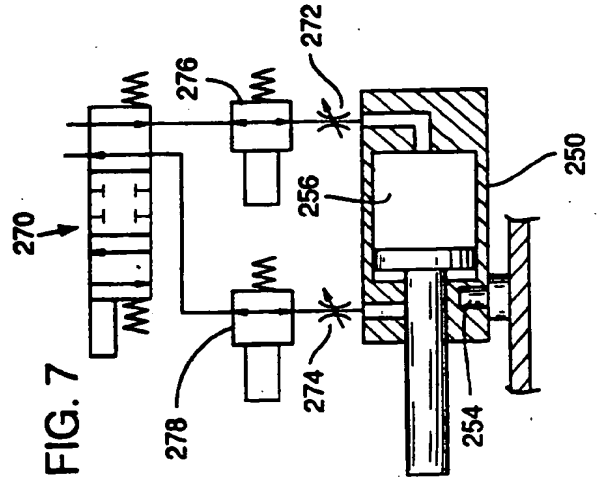
272
276
250
256
270
274
278
254

FIG. 7

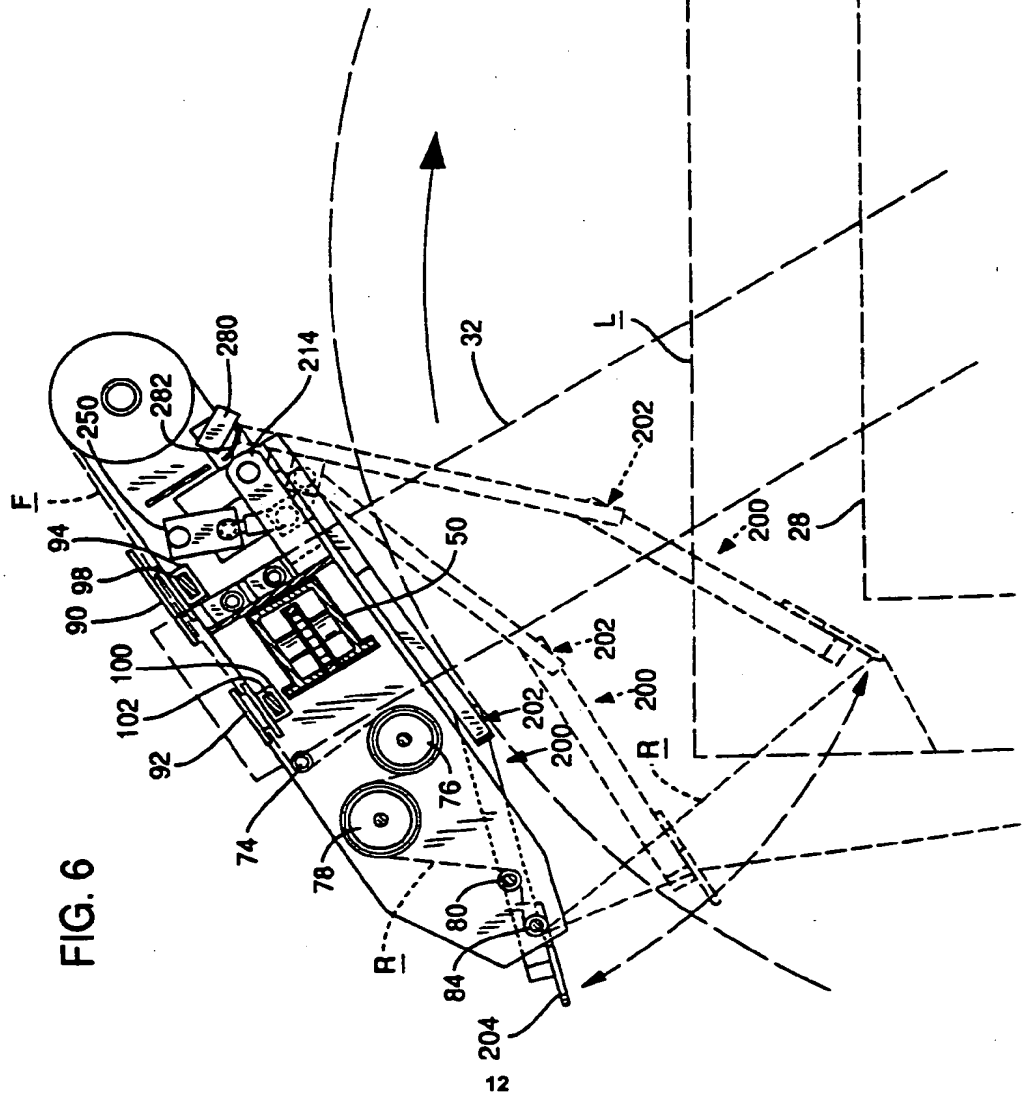
280
214
32
L
250
282
202
F
94
50
200
28
98
90
100
202
102
202
200
R
92
200
76
74
78
80
R
84
204

FIG. 6

FIG. 8

ROPE DIAGONALS AND ROPE WRAPS

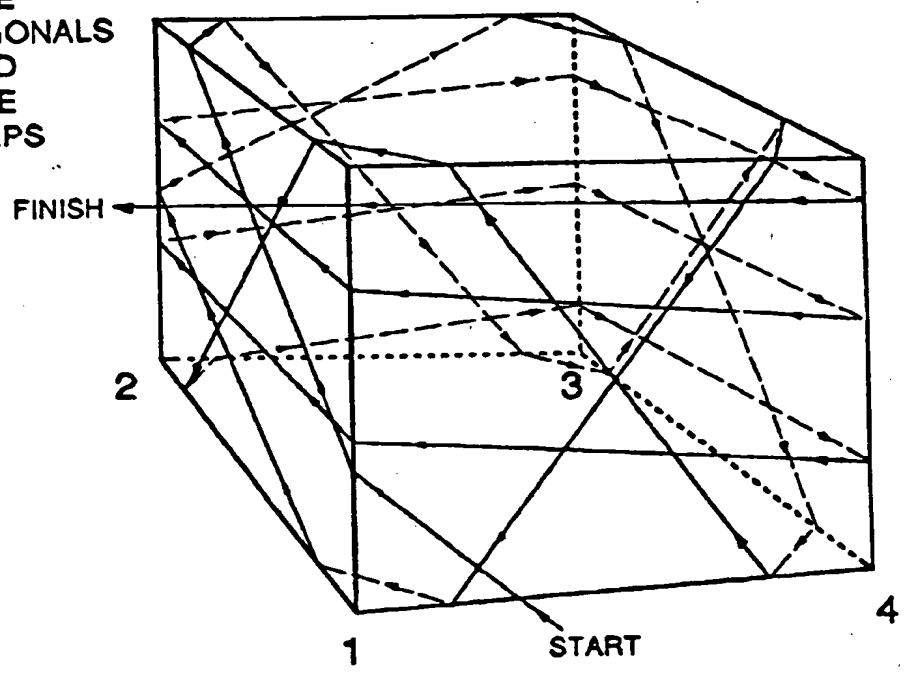

FIG. 9

SHEET WRAPS